Kevin J. Nietmann
Plant General Manager
Calvert Cliffs Nuclear Power Plant
Constellation Generation Group, LLC

1650 Calvert Cliffs Parkway
Lusby, Maryland 20657
410 495-4101
410 495-4787 Fax

Constellation Energy Group

July 27, 2004

U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit Nos. 1 & 2; Docket Nos. 50-317 & 50-318
Response to NRC Bulletin 2004-01, "Inspection of Alloy 82/182/600 Materials Used in the Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized-Water Reactors"

REFERENCE: (a) NRC Bulletin 2004-01: Inspection of Alloy 82/182/600 Materials Used in the Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized-Water Reactors, dated May 28, 2004

The purpose of this letter is to forward Calvert Cliffs Nuclear Power Plant, Inc.'s response to Nuclear Regulatory Commission (NRC) Bulletin 2004-01 (Reference a). The Bulletin was issued to:

1) advise Pressurized-Water Reactor (PWR) licensees that current methods of inspecting Alloy 82/182/600 materials used in the fabrication of pressurizer penetrations and steam space piping connections may need to be supplemented with additional measures to detect and adequately characterize flaws due to primary water stress corrosion cracking (PWSCC),

2) request PWR addressees to provide the NRC with information related to the materials from which the pressurizer penetrations and steam space piping connections at their facilities were fabricated,

3) request PWR licensees to provide the NRC with information related to the inspections that have been and will be performed to ensure that degradation of Alloy 82/182/600 materials used in the fabrication of pressurizer penetrations and steam space piping connections will be identified, adequately characterized, and repaired, and

4) require PWR addresses provide a written response to the NRC in accordance with the provisions of Section 50.54(f) of Title 10 of the Code of Federal Regulations.

The NRC requests that specific information be provided within 60 days of the date of the Bulletin. Attachment (1) contains Calvert Cliffs Nuclear Power Plant's response to the requested information.

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Should you have questions regarding this matter, we will be pleased to discuss them with you.

Very truly yours,

STATE OF MARYLAND :
: TO WIT:
COUNTY OF CALVERT :

I, Kevin J. Nietmann, being duly sworn, state that I am Plant General Manager - Calvert Cliffs Nuclear Power Plant, Inc. (CCNPP), and that I am duly authorized to execute and file this response on behalf of CCNPP. To the best of my knowledge and belief, the statements contained in this document are true and correct. To the extent that these statements are not based on my personal knowledge, they are based upon information provided by other CCNPP employees and/or consultants. Such information has been reviewed in accordance with company practice and I believe it to be reliable.

Subscribed and sworn before me, a Notary Public in and for the State of Maryland and County of Calvert, this 27th day of July, 2004.

DEENA L. CARNAHAN My Commission NOTARY PUBLIC Expires 04-15-2006 CALVERT COUNTY, MD

WITNESS my Hand and Notarial Seal: Deena L. Carnahan
Notary Public

My Commission Expires: 4-15-06
Date

KJN/GT/bjd

Attachment: (1) Response to NRC Bulletin 2004-01

cc: J. Petro, Esquire
J. E. Silberg, Esquire
Director, Project Directorate I-1, NRC
R. V. Guzman, NRC
H. J. Miller, NRC
Resident Inspector, NRC
R. I. McLean, DNR

ATTACHMENT (1)

RESPONSE TO NRC BULLETIN 2004-01

Bulletin 2004-01 Requested Information (1)

All subject [Pressurized Water Reactor] PWR licensees are requested to provide the following information within 60 days of the date of this bulletin.

Requested Information 1(a)

A description of the pressurizer penetrations and steam space piping connections at your plant. At a minimum, this description should include materials of construction (e.g., stainless steel piping and/or weld metal, Alloy 600 piping/sleeves, Alloy 82/182 weld metal or buttering, etc.), joint design (e.g., partial penetration welds, full penetration welds, bolted connections, etc.) and, in the case of welded joints, whether or not the weld was stress-relieved prior to being put in service. Additional information relevant with respect to determining the susceptibility of your plant's pressurizer penetrations and steam space piping connections to PWSCC [primary water stress corrosion cracking] should also be included.

CCNPP Response

Calvert Cliffs Units 1 and 2 Pressurizer Penetrations and Welds General Description

All pressurizer penetrations have a nominal operating temperature of 653°F for the portion of the nozzles or welds contained within the pressurizer internal space or within the pressurizer shell. All original heater sleeves (120 per unit) and instrument nozzles (7 per unit) were fabricated from mill annealed Alloy 600 pipe or machined bar stock, and attached to the pressurizer cladding via partial penetration (J-groove) welds made with Alloy 182 filler. Partial penetration welds were not stress-relieved. The Alloy 600 material has low inherent PWSCC resistance as a consequence of being low-temperature mill annealed (mill annealing temperature of 1740°F or less). Each instrument nozzle has, in addition to the attachment J-groove weld, a full penetration safe-end weld, which is external to the pressurizer shell. These safe-end welds were stress relieved. Each pressurizer has three steam space piping connections on the top head that feature an Alloy 182 weld between a low-alloy steel nozzle body and an austenitic stainless steel safe-end.

Calvert Cliffs Unit 1

Heater Sleeves Description

The Unit 1 pressurizer originally had 120 Alloy 600 heater sleeves. The heater sleeves are vertically oriented penetrations on the bottom head of the pressurizer. The heater sleeves are attached to the pressurizer bottom head cladding via a J-groove weld. There is no interference fit. The material is Alloy 600 pipe procured to American Society of Mechanical Engineers (ASME) SB-167.

During the 1994 refueling outage, 118 of the original 120 Unit 1 heater sleeves were electroplated with an 8.5 mil (0.0085 inch) thick layer of pure nickel over the upper 4 inches of the sleeve inner diameter. The nickel plating was applied to prevent inside diameter (ID) initiated PWSCC. Prior to plating the nozzles, visual examination identified Locations FF-1 and B-3 were leaking. These heater penetrations were subsequently plugged with Alloy 690 plugs using Alloy 52/152 weld filler. Sleeve CC-1 was plated, but after heater installation the heater failed. The plated sleeve was left in place, but was plugged with an Alloy 690 plug welded in place using Alloy 52/152 filler material. In 1998, one additional sleeve leaked (location B-1) and was plugged with an Alloy 690 plug and alloy 52/152 filler material.

Heater Sleeves Susceptibility

Both Calvert Cliffs units' have experienced leakage in the heater sleeves due to PWSCC (see Unit 2 description below for details). The same material heat was used to fabricate the original heater sleeves for both units. The first leaks occurred in the Unit 2 heater sleeves in 1989. The leaks were attributed to

PWSCC, with susceptible material and high residual stresses contributing to the failure. The original Unit 2 heater sleeves were reamed prior to welding the sleeves to the pressurizer. The reaming created a cold worked layer of material that permitted a higher level of residual stresses from welding to be retained. The Unit 1 heater sleeves were not subjected to the pre-weld reaming which reduced susceptibility to PWSCC due to reduced retained weld residual stresses. As mentioned above, nickel plating was applied for Unit 1 as a mitigative measure after the experience with the Unit 2 leaks. The nickel plating was applied in 1994, at which time two leaking heater sleeves were found. Sleeve B-3 had a short axial crack in the sleeve at the elevation of the J-groove weld, similar to the cracking observed in the Unit 2 heater sleeves (see below for details). The other sleeve (FF-1) had several deep circumferential cracks in the free-span region of the sleeve, outboard of the pressurizer shell. A root cause analysis (which included a destructive metallurgical evaluation) determined sleeve FF-1 had been highly cold worked during fabrication as a result of a stuck reamer, which had to be hammered out of the sleeve, producing high axial residual stresses in the lower part of the sleeve. Review of fabrication records showed this event was unique to sleeve FF-1.

Since 1994, only one additional heater sleeve leak has been discovered. During the 1998 refueling outage, we identified a leak at Location B-1. The root cause analysis that included a destructive metallurgical analysis attributed the failure to a PWSCC crack that may have been present prior to application of the nickel plating. A pre-existing crack would not have been discovered prior to plating because a volumetric nondestructive examination of the sleeves was not conducted prior to plating. Thermal fatigue stress cycles due to plant heat-up and cool-down may have caused failure of the nickel plating over the crack. A pre-existing crack would have been once again exposed to the reactor coolant environment, resulting in renewed propagation of the crack by PWSCC. Based on the occurrence of only one leak in ten calendar years of operation, the nickel plating has been effective in mitigating PWSCC.

Instrument Nozzles Description

Two instrument nozzles are located on the bottom head, one in the lower shell, and four in the upper head. The bottom head instrument nozzles are vertically oriented, while the other instrument nozzles are horizontally oriented. There is no interference fit. The nozzle material is Alloy 600 bar stock. The instrument nozzles are attached to the cladding via J-groove welds. The nozzles are welded flush with the pressurizer inner surface, i.e., no portion of the nozzle protrudes into the pressurizer interior.

The instrument nozzles also have a nozzle-to-safe-end full penetration butt weld. All Unit 1 nozzles have Alloy 82/182 filler metal between the Alloy 600 nozzle and the stainless steel safe-end.

Instrument Nozzles Susceptibility

All original Unit 1 and 2 pressurizer instrument nozzles were fabricated from the same material heat. The Alloy 600 material has low inherent PWSCC resistance as a consequence of being low temperature mill annealed. The instrument nozzles were machined on the inner diameter using fabrication techniques which would have created a cold worked layer. The operating temperature is relatively high, and the nozzles penetrate the vessel at relatively high angles with the exception of the nozzle located on the lower shell. The hillside angles are 25° for the top head nozzles, 35° for the bottom head nozzle, and 0° for the lower shell nozzle. As discussed below, in 1989, the Unit 2 top head instrument nozzle at the 7-½° location was discovered to be leaking. A metallurgical examination determined the leak was caused by PWSCC. As a result, these nozzles were determined to have high susceptibility to PWSCC. Consequently, we elected to preventively install mechanical nozzle seal assemblies (MNSAs) on all seven Unit 1 instrument nozzles (Reference 1).

The nozzle-to-safe-end butt welds have lower susceptibility to PWSCC than the J-groove welds for the following reasons:

1. The butt welds were stress relieved,
2. The location of the butt welds (external to the pressurizer shell) is at a lower temperature than the J-groove welds,
3. The constraint in the butt-weld joint is lower than in the J-groove joint which results in lower residual stresses.

Steam Space Piping Connections (Butt Welds) Description

There are three steam space piping connections that contain Alloy 182 weld filler material. These consist of one spray nozzle and two safety/relief nozzle connections. These connections feature an Alloy 182 butt weld (groove weld and buttering) joining a low alloy steel nozzle to an austenitic stainless steel safe-end. The safe-end is welded to the adjoining austenitic stainless steel piping using austenitic stainless steel weld filler. All three nozzles have a four inch nominal diameter. After the buttering was applied to the low-alloy steel nozzles, the nozzle assemblies were post-weld heat treated. However, the nozzle assemblies were not post-weld heat treated after the Alloy 182 groove weld was completed.

Steam Space Piping Connections (Butt Welds) Susceptibility

The three Alloy 182 butt welds in the Unit 1 steam space piping connections have been determined to be high in susceptibility relative to other Alloy 82/182 butt welds in the Reactor Coolant System. This assessment was based on the high operating temperature.

Calvert Cliffs Unit 2

Heater Sleeves Description

The 120 original heater sleeves in Unit 2 were replaced or plugged in 1989 as a result of discovering leakage in approximately 20 sleeves. Destructive examinations of several of the leaking sleeves determined the leaks were due to PWSCC. One hundred nineteen sleeves were replaced with Alloy 690 sleeves and one sleeve location was plugged with an Alloy 690 plug. Each replacement sleeve features an Alloy 690 outer sleeve, attached via a J-groove weld to a weld pad on the pressurizer bottom head outer surface and seal welded to the pressurizer inner shell cladding. The autogenous seal weld prevents any part of the external weld pad from coming into contact with reactor coolant. An Alloy 690 inner sleeve is attached to the outer sleeve via a partial penetration weld. Both the outer-sleeve-to-pad weld and the inner-sleeve-to-outer-sleeve weld were made with Alloy 82 weld filler.

Heater Sleeves Susceptibility

The Unit 2 heater sleeve base material is Alloy 690 and is thus considered to have minimal or no PWSCC susceptibility. The outer-sleeve–to-pad and the inner-sleeve-to-outer-sleeve welds are Alloy 82, thus are considered to have some susceptibility to PWSCC. However, the outer sleeve-to-pad-weld is not exposed to the reactor coolant. The inner-to-outer sleeve weld is exposed to reactor coolant at the weld root. However, several factors minimize the PWSCC susceptibility of this weld:

- The weld geometry is less constraining than a J-groove weld of a tube to a vessel, thus residual stresses should be lower than in an original nozzle J-groove weld.
- Direct measurement of the temperature of the inner-to-outer sleeve weld indicated an external temperature of 571°F. The estimated internal temperature is 576°F, based on the internal-to-external temperature differential determined by a finite element model. The finite element model

was constructed for a Unit 1 heater sleeve. Some input parameters were adjusted to account for differences between Unit 1 and 2. The model was used to estimate the temperature differential that was added to the measured outer diameter temperature from Unit 2. Temperature is known to be an important factor in PWSCC susceptibility. Most industry Alloy 600 PWSCC failures have been in penetrations operating at 600°F or higher.

- Service experience has shown Alloy 82 is more resistant to PWSCC than Alloy 182 which is probably due to its higher chromium content.

Instrument Nozzles Description

The original Unit 2 instrument nozzles were identical to the corresponding Unit 1 nozzles with respect to material and design. In 1989, one of the four nozzles located on the top head (at the 7-½° location) was found leaking. Metallurgical analysis determined that PWSCC caused the leak. Consequently, all four top head instrument nozzles were replaced with Alloy 690 nozzles. The replacement nozzles were attached to the top head cladding via a J-groove weld, similar to the original design. Alloy 82 weld filler was used to make the J-groove welds. In 1998, the replacement 7- ½° nozzle was found to be leaking. The leak was determined to have been caused by PWSCC of the weld filler. The 7-½° location was believed to be more susceptible to PWSCC due to the removal of a metallurgical sample from this section for the 1989 analysis. As a result, a larger amount of weld filler was necessary in the J-groove weld which permitted higher residual weld shrinkage stresses to develop. The 7-½° nozzle was replaced with a new Alloy 690 nozzle attached via a J-groove weld to a temper bead weld pad on the outer surface of the pressurizer. The J-groove weld and weld pad are Alloy 52/152.

The original instrument nozzles (one on the lower shell and two on the bottom head) remain in service. Mechanical nozzle seal assemblies have been installed on these three nozzles (Reference 1).

The instrument nozzles also have a nozzle-to-safe-end full penetration butt weld. The upper level 7-½° location nozzle has Alloy 52/152 filler material between Alloy 690 nozzle and the stainless steel safe-end. The other three upper level nozzles have Alloy 82/182 filler material between the Alloy 690 nozzle and the stainless steel safe-end. The mid-level and lower level nozzles have the original Alloy 82/182 filler material between Alloy 600 nozzles and stainless steel safe-end.

Instrument Nozzle Susceptibility

The 7-½° top head instrument nozzle uses only Alloy 690 and Alloy 52 weld filler metal in the pressure boundary. Therefore, this nozzle is not considered susceptible to PWSCC. The other three top head nozzles combine Alloy 690 nozzles with Alloy 82 welds. These nozzles are considered to have some susceptibility to weld metal PWSCC. J-groove welds created as field replacement welds are believed to be more susceptible to PWSCC than original welds because they do not receive the benefit of a shop hydrostatic test, which relieves residual stresses. Factors increasing the susceptibility of Alloy 82 or 182 J-groove welds include:

- Field repair weld
- Shielded Metal Arc Welding techniques (i.e. Alloy 182 weld metal)
- Large weld volume
- High operating temperature (pressurizer)

The pressurizer top head instrument nozzles, with the exception of the 7-½° location nozzle, are field repair welds with a high operating temperature. The 7-½° location nozzle had these factors plus a large weld volume. Therefore, the nozzles other than the 7-½° location nozzle have moderate susceptibility to PWSCC, but are less susceptible than the 7-½° location nozzle was prior to its 1998 repair.

The other three instrument nozzles (one located on the lower shell and two on the bottom head) are considered to have high PWSCC susceptibility as a result of being fabricated of Alloy 600 material with a low inherent resistance to PWSCC (low temperature mill annealed material), and the high operating temperature of 653°F. However, as mentioned above, MNSAs have been installed on these nozzles.

The susceptibility of the nozzle-to-safe-end butt welds to PWSCC is as described for Unit 1 above.

Steam Space Piping Connections (Butt Welds) Description

The configuration and materials of the Unit 2 steam space piping connections are identical to those used in Unit 1, as described above.

Steam Space Piping Connections (Butt Welds) Susceptibility

The susceptibility of the Unit 2 steam space piping connections are identical to those used in Unit 1, as described above.

Requested Information 1(b)

A description of the inspection program for Alloy 82/182/600 pressurizer penetrations and steam space piping connections that has been implemented at your plant. The description should include when the inspections were performed: the areas, penetrations and steam space piping connections inspected; the extent (percentage) of coverage achieved for each location which was inspected; the inspection methods used; the process used to resolve any inspection findings; the quality of the documentation of the inspections (e.g., written report, video record, photographs); and, the basis for concluding that your plant satisfies applicable regulatory requirements related to the integrity of pressurizer penetrations and steam space piping connections. If leaking pressurizer penetrations or steam space piping connections were found, indicate what follow-up NDE [nondestructive examination] was performed to characterize flaws in the leaking penetrations.

CCNPP Response

Description of Inspection Program for Heater Sleeves and Instrument Nozzles

Since 1989 Calvert Cliffs Nuclear Power Plant (CCNPP) has been performing augmented inspections of the Unit 1 pressurizer heater sleeves and instrument nozzles. The following two types of examinations are performed in accordance with the CCNPP Boric Acid Corrosion Inspection Program.

1. During each reactor shutdown where a hot standby (Mode 3) condition is reached a VT-2 examination (as described in ASME Section XI, IWA-2212) is performed to detect evidence of leakage. The exam is performed from a location that will directly view the visible portion of the pressurizer heater sleeve, the insulation and insulation seams around the penetration point. This examination need not be performed if a similar examination has been performed in the past 30 days.
2. During each refueling outage (Mode 6), a visual examination (VT-1), as described in ASME Section XI, IWA-2211, is performed to detect evidence of leakage by viewing each penetration region for boron deposits. This is a "bare metal visual" (BMV) examination.

These examinations have been extended to the Unit 2 pressurizer heater sleeves and instrument nozzles since 1993. This means that these penetrations and any MNSAs installed on them have had BMV examinations by VT-2 qualified NDE Examiners every refueling outage. For nozzles without a MNSA, BMV examination is defined as inspection of the intersection between the low alloy steel vessel surface and the Alloy 600 nozzle surface. For nozzles with MNSAs, BMV examination is defined as inspection of the intersection of the MNSA surfaces and the low alloy steel pressurizer surfaces, inspection of the MNSA surfaces, and inspection of the intersection of the Alloy 600 nozzle and the MNSA. The inspection scope for nozzles with MNSAs comprise all pressure boundary surfaces associated with the penetration, shell, and MNSAs. Calvert Cliffs Nuclear Power Plant does not currently have MNSA installed on any penetrations that have leaks. Visual examination results are documented in written NDE reports. Photographs may or may not be included with the documentation.

Description of Inspection Program for Steam Space Piping (Butt Weld) Connections

The steam space piping connections have been visually inspected (VT-2) for leakage as part of the in-service leakage test every refueling outage. The steam space piping connections have also been inspected in accordance with ASME Section XI with surface and volumetric examinations done in accordance with the Code by certified NDE examiners. These examinations were done prior to the implementation of ASME Section XI, Appendix VIII, Supplement 10 and Performance Demonstration Initiative requirements for the examination of dissimilar metal welds. The examinations were limited to single-sided examinations due to the configuration of the nozzles.

Prior to the 2004 Unit 1 refueling outage, insulation was not removed for the VT-2 inspection. During the Unit 1 2004 refueling outage, we began implementation of inspections in accordance with the Materials Reliability Program recommendations for visual examination of the dissimilar metal welds containing Alloy 82/182 weld metal. We performed BMV examinations of all the pressurizer steam space piping connections containing Alloy 182 weld metal. These examinations were performed by VT-2 certified examiners. All examination results are documented in written NDE reports which include photographs.

Table 1 below shows the weld identification number, description, dates examined and the next scheduled examination dates for the ASME Section XI In-service Inspection examination of dissimilar metal welds in the steam space piping connections.

Table 1
Steam Space Piping Connection Surface and Volumetric Examination History

Weld ID No.	Description	Dates Examined	Next Scheduled
U-1-118500 (Unit 1)	Pressurizer Spray Safe-End to Pressurizer Nozzle	1986, 1988, 2000	2008
U-1-123100 (Unit 1)	Pressurizer Nozzle to Safe-End RV-200	1980 1996	2008
U-1-123450 (Unit 1)	Pressurizer Nozzle to Safe-End RV-201	1980, 1994	2008
U-2-136090 (Unit 2)	Pressurizer Spray Safe-End to Pressurizer Nozzle	1978, 1989, 2001	2005
U-2-141000 (Unit 2)	Pressurizer Nozzle to Safe-End RV-200	1981, 1997	2005
U-2-142000 (Unit 2)	Pressurizer Nozzle to Safe-End RV-201	1984, 1997	2005

CCNPP Pressurizer Leakage Events

1989 CCNPP Unit 2

In May 1989, we discovered approximately 20 pressurizer heater sleeves and one upper instrument nozzle penetration leaking on Unit 2. To characterize the flaws, we performed eddy current and liquid penetrant (PT) examination of all nozzles suspected of leaking. We also performed PT examinations on the surface of the attachment J-groove welds on the inside of the pressurizer. Destructive metallurgical analyses of several heater sleeves and one instrument nozzle verified that axial PWSCC associated with stresses due to welding caused the leakage. Prior to performing the destructive examination, extensive, multiple modality NDE (i.e., UT, PT, and ET) was performed. The destructive analysis results were used to validate the NDE. As mentioned above, all 120 Unit 2 heater sleeves and all four steam space instrument taps were repaired.

Examinations were expanded to Unit 1 to verify the extent of condition. One hundred percent visual examinations were done of all 120 heater sleeve penetrations and 7 pressurizer instrument nozzles. Eddy current and PT examinations were performed on 12 (10%) of the heater sleeves and 2 (50%) of the steam space instrument taps to verify their acceptability. No indications were found. The eddy current examination employed a pancake coil array scanned in a boustrophedonic mode, and was capable of identifying either axial or circumferential cracking on the ID of the sleeve. The technique was validated by the Unit 2 destructive examination results.

1994 CCNPP Unit 1

In March 1994, during a pressurizer heater sleeve nickel plating evolution, we identified two leaking pressurizer heater sleeves in Unit 1. We performed visual, PT, and eddy current examinations to characterize the cause of the leakage. Location B-3 leaked due to an axial through wall crack adjacent to the J-groove weld. Location FF-3 (which was destructively examined) leaked due to multiple through wall circumferential cracks on a portion of the heater sleeve outside of the pressurizer shell. Full length examination of 29 additional Unit 1 heater sleeves using the motorized rotating pancake coil eddy current technique revealed no other indications. The remaining Unit 1 heater sleeves were then nickel plated in the region most susceptible to PWSCC.

1998 CCNPP Unit 1

As discussed above, during the 1998 refueling outage, we identified one leaking pressurizer heater sleeve at the B-1 location in Unit 1. Ultrasonic examination revealed the flaw was located adjacent to the J-groove weld and had axial orientation. The sleeve was removed for destructive analysis, and the location was plugged with Alloy 690 materials. The destructive analysis validated that the crack was located and oriented as indicated by the UT results.

1998 CCNPP Unit 2

In July 1998, we identified a leak on a previously repaired upper instrument nozzle on the upper head of the Unit 2 pressurizer. The previous repair employed Alloy 690 tubing with Alloy 82 weld material. We performed PT examination of the nozzle to verify there were no cracks through the nozzle wall. Leakage was attributed to degradation of the Alloy 82 attachment weld. The nozzle was replaced with an Alloy 690 half nozzle welded into place with Alloy 52 filler metal.

Basis for Concluding Applicable Regulatory Requirements are Satisfied

See response to Requested information 1(d) below.

Requested Information 1(c)

A description of the Alloy 82/182/600 pressurizer penetrations and steam space piping connection inspection program that will be implemented at your plant during the next and subsequent refueling outages. The description should include the areas, penetrations and steam space piping connections to be inspected; the extent (percentage) of coverage to be achieved for each location; inspection methods to be used; qualification standards for the inspection methods and personnel; the process to be used to resolve any inspection indications; the inspection documentation to be generated; and the basis for concluding that your plant will satisfy applicable regulatory requirements related to the structural and leakage integrity of pressurizer penetrations and steam space piping connections. If leaking pressurizer penetrations or steam space piping connections are found, indicate what follow-up NDE will be performed to characterize flaws in the leaking penetrations. Provide your plans for expansion of the scope of NDE to be performed if circumferential flaws are found in any portion of the leaking pressurizer penetrations or steam space piping connections.

CCNPP Response

Description of Future Inspection Program for Calvert Cliffs Unit 1

Heater Sleeves

Future inspection plans for the Unit 1 heater sleeve penetrations will continue to include 100% BMV examinations of all heater sleeve penetrations each refueling outage. These examinations will be performed by VT-2 certified NDE examiners in accordance with ASME Section XI. If leakage is found on a heater sleeve, ultrasonic examination will be performed to characterize the flaw causing the leakage (UT has been the preferred technique for nickel plated components). If the flaw is determined to be a circumferential flaw in the Alloy 600 material, the remaining heater sleeves will be examined to determine the extent of condition.

Instrument Nozzles

Future inspection plans for the Unit 1 instrument nozzle penetrations will continue to include 100% BMV examinations of all instrument nozzle penetrations and any associated MNSA each refueling outage. The MNSA would not be disassembled. If leakage is identified on one of these instrument nozzle penetrations with a MNSA installed, the affected MNSA will be disassembled and the corrective action process will be used to ensure the penetration remained within the design basis for the MNSA installation (Reference 1). If the leakage is caused by something other than the design of the MNSA, other penetrations will be examined to determine generic implications.

Steam Space Piping (Butt Weld) Connections

Future inspections for the Alloy 182 butt welds in the Unit 1 steam space piping connections will include BMV examinations every refueling outage until remediation (probably Mechanical Stress Improvement Process or weld overlay) is performed (currently planned for 2006). In addition to the BMV examinations, these welds are collectively scheduled to receive their ASME Section XI examinations for the third inspection interval during the next two refueling outages. These examinations will employ the requirements of ASME Section XI, Appendix VIII, Supplement 10 as implemented through the Performance Demonstration Initiative requirements for the examination of dissimilar metal welds. Following remediation, the inspection on these welds will revert to those required by ASME Section XI or other more restrictive approved industry guidance that may be developed.

If leakage occurred at one of the Alloy 182 butt welds in the Unit 1 steam space piping connections, the appropriate surface and volumetric examination methods will be employed to characterize the flaws. Examinations will be expanded to include other steam space piping connections and any others deemed to be susceptible to the same failure mechanisms.

Description of Future Inspection Program for Calvert Cliffs Unit 2

Heater Sleeves

Future inspection plans for the Unit 2 heater sleeve penetrations will continue to include 100% BMV examinations of all heater sleeve penetrations each refueling outage. These exams will be performed by VT-2 certified NDE examiners in accordance with ASME Section XI. If leakage occurred at a heater penetration, we will perform examinations to determine the extent of condition and whether circumferential flaws existed. If circumferential flaws are identified, we will expand our inspection scope to the remaining sleeves to ascertain the extent of condition.

Instrument Nozzles

Future inspection plans for Unit 2 instrument nozzle penetrations will continue to include 100% BMV examinations of all instrument nozzle penetrations and any associated MNSA each refueling outage. The MNSA will not be dissembled for the examination. If leakage was identified on one of the instrument nozzle penetrations with a MNSA installed, the affected MNSA will be disassembled and the corrective action process will be used to ensure the penetration remained within the design basis for the MNSA installation (Reference 1). If the leakage was caused by something outside the design of the MNSA, other penetrations will be examined to determine generic implications. If leakage occurs from one of the three top head instrument nozzles which utilize Alloy 690 and an Alloy 82 J-groove weld, examinations will be performed to characterize the cause of leakage.

Steam Space Piping (Butt Weld) Connections

Future inspection plans for Alloy 182 butt welds in Unit 2 steam space piping will include BMV examinations every refueling outage until remediation (probably Mechanical Stress Improvement Process or weld overlay) is performed (currently planned for 2007). In addition to the BMV examinations, these welds are scheduled to receive ASME Section XI examinations for the third inspection interval during the 2005 refueling outage. These examinations will employ the requirements of ASME Section XI, Appendix VIII, Supplement 10 as implemented through the Performance Demonstration Initiative requirements for the examination of dissimilar metal welds. Following remediation, the inspection on these welds will revert to those required by ASME Section XI or other more restrictive approved industry guidance that may be developed.

If leakage occurs at one of the Alloy 182 butt welds in the Unit 2 steam space piping connections the appropriate surface and volumetric examination methods will be employed to characterize the flaws. Examinations will be expanded to include other steam space piping connections.

Basis for Concluding Applicable Regulatory Requirements will be Satisfied

See response to Requested information 1(d) below.

Requested Information 1(d)

In light of the information discussed in this bulletin and your understanding of the relevance of recent operating experience to your facility, explain why the inspection program identified in your response to item (1)(c) above is adequate for the purpose of maintaining the integrity of your facility's RCPB [reactor *coolant pressure boundary] and for meeting all applicable regulatory requirements which pertain to your facility.*

CCNPP Response

Reasons for the Adequacy of Future Inspection Program

For all Alloy 82/182/600 in CCNPP pressurizer penetrations and steam space piping connections, we will be implementing an inspection program consistent with the Westinghouse Owners Group recommendations described in the Bulletin (Reference 2) including the modifications proposed by the Nuclear Regulatory Commission staff.

The recent degradation discussed by Bulletin 2004-01 consisted of circumferential cracking above the weld in pressurizer heater sleeves, and axially oriented cracks in Alloy 82/182 welds in steam space piping connections. The occurrence of circumferential cracking above the weld in heater sleeves suggests the possibility that such cracking could occur below the weld, leading to the risk of failure of the penetration. Circumferential cracking below the weld in heater sleeves is unlikely at either Calvert Cliffs unit. This is due to the fact that the sleeves on Unit 2 are fabricated from Alloy 690 material which is not susceptible to PWSCC and the Unit 1 sleeves have been plated with pure nickel to prevent ID initiated cracking. Initiation of outer diameter (OD) PWSCC below the weld on the Unit 1 sleeves would require exposure of this part of the sleeve to reactor coolant. Reactor coolant could reach the outer diameter below the weld via a through-weld crack, but this would produce boric acid leakage detectable by BMV examination prior to the occurrence of a significant OD initiated through-wall crack. This statement is supported by previous experience with heater sleeve leakage at Calvert Cliffs. Although significant axial cracking was observed, no circumferential cracking (either ID or OD) near the welds was observed.

One heater sleeve in Unit 1 was found to have free-span (external to the pressurizer shell, remote from the weld) circumferential cracking attributed to cold work from a stuck reamer during fabrication. Evaluation of fabrication records for all Unit 1 heater sleeves found this event was unique to one sleeve. Therefore, the proposed inspection program, which is consistent with the inspection program proposed by this Bulletin, is adequate to ensure the integrity of the Unit 1 pressurizer penetrations and associated welds.

In the Unit 2 pressurizer penetrations PWSCC could occur only in the Alloy 82 J-groove welds. Such a leak would be readily detectable since these welds are external to the pressurizer. However, as discussed in the response to Requested Information 1(a) above, PWSCC of these welds is judged to be unlikely. Therefore, the proposed inspection program, which is consistent with the inspection program proposed by this Bulletin is adequate to ensure the integrity of the Unit 2 pressurizer penetrations and associated welds.

Calvert Cliffs Units 1 and 2 steam space connection butt welds with Alloy 182 are bounded by a safety assessment performed under the guidance of the Electric Power Research Institute, Materials Reliability Program, Alloy 600 Issue Task Group (Reference 3). Therefore, the proposed inspection program, which is consistent with the inspection program proposed by this Bulletin, is adequate to ensure the integrity of these welds.

Compliance with Applicable Regulatory Requirements

Although CCNPP was designed and constructed to meet the intent of the draft General Design Criteria (GDC) issued on July 10, 1967, by the Atomic Energy Commission, our inspection and repair program for pressurizer penetrations and steam space connection can also be shown to meet the requirements of GDC 14, 31, and 32. We remain committed to the draft GDC as described in the Updated Final Safety Analysis Report. General Design Criteria 14 specifies that the RCPB be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure and of gross rupture. General Design Criteria 31 specifies that the probability of rapidly propagating fracture of the RCPB be minimized. General Design Criteria 32 specifies inspection requirements for RCPB. Calvert Cliffs meets the requirements of GDC 14 and 31 because we have evaluated the probability of leakage, rapidly propagating failure, and gross rupture of our pressurizer Alloy 600 components (and Alloy 82/182 welds) under our Alloy 600 Program Plan. For components judged to have a significant probability of leakage, Calvert Cliffs has taken corrective action to repair, replace, or perform mitigation to reduce the probability of leakage. Calvert Cliffs meets the requirements of GDC 14 and 31 because the probability of rapidly propagating failure/fracture is minimal for all Alloy 600 pressurizer components as a result of the large critical crack sizes for this material. The presence of cracks will be detected via boric acid inspection program long before cracks grow to critical size. Boric acid corrosion evaluations have determined pressure boundary integrity will not be threatened due to boric acid corrosion provided boric acid inspections are performed during each refueling outage. Calvert Cliffs meets the requirements of GDC 32 because all Alloy 600 RCPB components in the pressurizer, and Alloy 82 and 182 RCPB welds in the pressurizer, have the capability to be periodically inspected to assess their structural and leak-tight integrity. By evaluating our program against current GDC 14, 31, and 32, we also demonstrate compliance with the equivalent draft GDC and remain committed to them.

Calvert Cliffs is in compliance with 10 CFR 50.55a because we do not have existing reactor coolant pressure boundary leaks or degradation. Examination requirements, acceptance standards, supplemental examinations, corrective measures and repairs, analytical evaluation, all meet or exceed ASME Section XI requirements for pressurizer components.

Calvert Cliffs is in compliance with Criterion V (Instructions, Procedures, and Drawings) of Appendix B to 10 CFR Part 50 in that we have procedures, instructions, and drawings that control our inspections. We document inspection results in accordance with this criterion.

Calvert Cliffs is in compliance with Criterion IX (Control of Special Processes) of Appendix B to 10 CFR Part 50 in that special processes, including nondestructive testing, are controlled and accomplished by qualified personnel using qualified procedures in accordance with applicable codes, standards, specifications, criteria, and other special requirements.

Calvert Cliffs is in compliance with Criterion XVI (Corrective Action) of Appendix B to 10 CFR Part 50 in that we are performing proactive inspections of the RCPB to discover evidence of RCPB deterioration due to either PWSCC or boric acid corrosion. Additionally, we will perform a root cause analysis of any abnormal degradation. Such analyses have been performed for pressurizer heater sleeve leakage in Calvert Cliffs Unit 1 and Unit 2, and pressurizer top head instrument nozzle leakage in Calvert Cliffs Unit 2, leading to corrective actions such as replacement of nozzles, mitigation (nickel plating), and implementation of enhanced visual inspections.

Calvert Cliffs remains in compliance with plant Technical Specifications in that we are not operating, nor do we plan to operate, with identified RCPB leakage.

REFERENCES

1. Letter from R. J. Laufer (NRC) to P. E. Katz (CCNPP), dated August 7, 2002, "Request for Relief for Temporary Installation of Mechanical Nozzle Seal Assemblies at the Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2 (TAC Nos. MB0557 and MB0558)

2. NRC Bulletin 2004-01: Inspection of Alloy 82/182/600 Materials Used in the Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized-Water Reactors, dated May 28, 2004

3. PWR Materials Reliability Project Interim Alloy 600 Safety Assessments for US PWR Plants (MRP-44) Part 1: Alloy 82/182 Pipe Butt Welds Interim Report, April 2001